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MONITORING OF AIR QUALITY PARAMETERS AT DIFFERENT MONTHS: A CASE STUDY FROM IRAN

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ABSTRACT
The aim of this paper is to investigate of seasonal variations of ozone (O_3), nitrogen oxides (NOx), sulphur dioxide (SO_2), carbon monoxide (CO) and dust in Kermanshah city, Iran. The concentrations of these parameters were monitored by continuous monitoring equipment for a period of two years. There were significant monthly variations in concentrations of air quality parameters, while concentrations of air quality parameters are relatively similar in 2008 than that in 2009. In 2008, the O_3 concentration ranged from 2.3 to 34.3 ppb, NOx from 17.8 to 84.4 ppb, dust from 68.6 to 236.2 µg/m3, SO_2 from 19.5 to 28.1 ppb, CO from 1.2 to 2.7 ppm. In 2009, the O_3 concentration ranged from 3.2 to 32.4 ppb, NOx from 19.5 to 79.0 ppb, dust from 68.4 to 257.3 µg/m3, SO2 from 19.5 to 30.7 ppb, CO from 1.1 to 3.4 ppm. The air quality monitoring data collected in city center of Kermanshah showed seasonal variations for ozone (O_3), nitrogen oxides (NOx), sulphur dioxide (SO_2), carbon monoxide (CO) and dust concentrations.

KEYWORDS: air pollution; Kermanshah city; seasonal variations; traffic emissions

INTRODUCTION
The increasing development of human activities has given rise to a significant increase in atmospheric pollutants which may have an impact on human health [Atash, 2007]. Many developing countries have experienced a progressive degradation in air quality as a consequence of rapid development over the last three decades [Agrawal *et al*., 2003]. In the cities of developing countries, the environmental problems are much greater, because of the overwhelming scale and speed of urbanization [Atash, 2007]. In particular, the levels of air pollutants are increasing rapidly in urban areas in many mega cities of the developing world [Agrawal *et al*., 2003]. It is well known that air pollution can harm human health [Zhang *et al*., 2007]. The increased risks were observed mainly for the population exposed to urban air which is affected predominantly by traffic emissions, emissions from household heating and industries [Škarek *et al*., 2007]. Air pollution is one of the most serious environmental problems in Iran, In Iran, urban air pollution is the result of emissions from a multiplicity of sources, mainly stationary, industrial and domestic fossil fuel combustion, motor vehicles emissions and ineffective environmental regulations.

Studies of urban air quality have shown that human health is negatively impacted by many types of gases and particles that result from the chemical reactions of exhaust gases with the atmosphere [Taseiko *et al*., 2009]. Air pollution is a very complex mixture consisting of hundreds of different inorganic and organic compounds [Škarek *et al*., 2007]. The inhabitants of a typical urban center may be exposed to about 40 individual chemicals and/or groups of chemicals, totalling more than 100 individual chemical species [Cairncross *et al*., 2007]. Urban air pollution is a major focus of public health concern and regulatory activity [Scoggins *et al*., 2004]. Air pollution has been associated with acute reductions in lung function, aggravation of asthma, increased risk of pneumonia in the elderly, low birth weight in newborns and death.

Adverse effects of air pollution include an increase in cardiovascular and respiratory deaths among elderly people as well as increased hospital admissions for heart and respiratory diseases [Harrabi *et al*., 2006]. A large number of epidemiological studies have shown that current day outdoor air pollution is associated with significant adverse effects on public health [Hoek *et al*., 2008]. Many studies have also shown the association with increased daily mortality, in total and due to cardiovascular and respiratory causes [Cairncross *et al*., 2007]. Adverse effects of air pollution on human health and a close relationship between the levels of air pollution and increased frequencies of certain diseases have been proved by numerous epidemiological studies [Škarek *et al*., 2007]. Over the past decade, many epidemiologic studies have found associations between ambient air pollutant levels and non-accidental daily total mortality [Yang *et al*., 2004]. Researchers have reported associations between chronic exposure to traffic and adverse cardiovascular health effects including hypertension,

myocardial infarction, stroke, atherosclerosis, heart disease, and mortality [Allen *et al.*, 2009]. There is good evidence of the relationship between urban air pollution and morbidity and mortality and that children may be especially susceptible to the effects of air pollution, especially particulate pollution [Jalaludin *et al.*, 2004]. There is an increasing interest in the impact that chronic exposure to ambient air pollution has upon both cardiac and respiratory health [Wheel *et al.*, 2008]. In clinical studies, ozone (O_3), nitrogen oxides (NOx), sulphur dioxide (SO_2), carbon monoxide (CO) and dust have been shown to exacerbate asthma, primarily by augmenting airway inflammation [Wilson *et al*., 2004]. The objective of this paper is to investigate of seasonal variations of ozone (O_3), nitrogen oxides (NOx), sulphur dioxide (SO_2), carbon monoxide (CO) and dust and their trends in Kermanshah city, Iran.

MATERIALS AND METHODS

SITE DESCRIPTION

Kermanshah is the capital city of Kermanshah Province, located in the west of Iran. Its latitude and longitude coordinates are from 34° 18' N and 47° 4' E, respectively. It has a moderate and mountainous climate. Its average rainfall is 445 mm and unevenly distributed throughout the year. Kermanshah experiences rather cold winters and there are usually rainfalls in autumn (Nov and Dec), winter (Jan, Feb and Mar) and spring (Apr and May), with the highest in Mar and Apr. Summer in Kermanshah is fairly hot. The height of Kermanshah city is 1420 m above sea level. The average annual temperature is 14.2 ºC with the warmest month in Jul (high average 38 ºC) and the coldest in Jan (low average -3.2 ºC). The sunlight of the month is 245 h. The average annual wind is 3.4 m/s.

METHODS

An air quality monitoring station has been established in Kermanshah city by the Environmental Protection Agency (EPA) of Iran. It is a continuous air quality monitoring station in the Kermanshah. It 1s located in the city centre with high traffic (Fig. 1). The monitoring station was fully automated and provided daily readings of ozone (O_3), nitrogen oxides (NOx), sulphur dioxide (SO_2), carbon monoxide (CO) and dust. The concentrations of these parameters were monitored by continuous monitoring equipment (UV absorption O_3 analyser-model 400A, chemiluminescent NOx analyser- model 200A, fluorescent SO_2 analyser-model 100A, gas filter correlation CO analyser-model 300). The inlets of sampling are located approximately 5 m above the ground at station.

One-way analysis of variance (ANOVA) was used to evaluate differences between the air quality parameters (O_3, NOx, SO_2, CO and dust) of the city centre of Kermanshah (period of two years), by Turkey's Honest. Pearson's correlation coefficients (r) were used when calculating correlations among these parameters. These are because of normalization of data. Data analyses were carried out using the statistical package Minitab (Release 14).

RESULTS AND DISCUSSION

While outdoor concentrations have generally fallen in recent decades in the cities of Western Europe and North America, there have been increases in urban air pollution concentrations in many cities of Asia, Africa and Latin America [Ashmore and Dimitroulopoulou, 2009]. In many cities of developing countries, the levels of air pollutants often exceed toxic limits and adversely affect human health, vegetation and built cultural heritage [Singha *et al.*, 2005]. Air pollution has become one of the most visible environmental problems in some city of Iran. Air pollutant sources of Iran classifies into three categories: (1) motor vehicles; (2) factories, workshops and power plants; and (3) business, domestic and miscellaneous sources [Atash 2007]. Motor vehicles (traffic) are the major source of air pollution in most parts of Iran. Another important source of air pollutants in Iran is combustion of fuels for heating of buildings. Thus, it seems that air pollutants in the heating and non-heating seasons are different.

Monthly mean ozone (O_3), nitrogen oxides (NOx), sulphur dioxide (SO2), carbon monoxide (CO) and dust concentrations at air quality monitoring station during 2008- 2009 is shown in Table 1. The concentrations of air quality parameters were monthly different in 2008 and 2009. Air monitoring conducted in Kermanshah has shown that the minimum and maximum O_3 concentration ranged from 2.3 (in Nov) to 34.3 ppb (in Jun), NOx from 17.8 (in Jun) to 84.4 ppb (in Jan), dust from 68.6 (in Dec) to 236.2 µg/m3 (in Jun), SO_2 from 19.5 (in May) to 28.1 ppb (in Oct), CO from 1.2 (in Jun) to 2.7 ppm (in Jan) in 2008. Also, the concentrations of air quality parameters were different in the different month in 2009. In this year, the minimum and maximum O_3 concentration ranged from 3.2 (in Mar) to 32.4 ppb (in Jul), NOx from 19.5 (in Jun) to 79.0 ppb (in Jan), dust

from 68.4 (in Jan) to 257.3 µg/m3 (in Jul), SO2 from 19.5 (in Jun) to 30.7 ppb (in Sep), CO from 1.1 (in Jul) to 3.4 ppm (in Feb). From the meteorological data it is clear that rains were frequent in Jan, Feb, Mar, Apr and Dec, and hence some of the pollutants including O_3 and dust, showed lower values during these months. In Jun, Jul and Aug, however, O_3 formation increased with a longer sunshine period. In general, there are many more studies that have reported positive associations between ambient air pollution and respiratory symptoms and asthma medication use. A few studies have demonstrated associations between ozone concentrations and lower respiratory symptoms [Jalaludin *et al*., 2004]. The level of SO_2 observed in the present study is higher to that of Yang et al. [2004], but O3 and CO levels are low. The level of CO observed in the present study is lower to that of Pourmahabadian and Mansouri, [Pourmahabadian and Mansouri, 2006]. . The main source of CO concentration in Kermanshah as a non- industrialized city is traffic. Hence the main force to decrease the citizens exposure to the air pollutants must be focused on improving public transportation, traffic and renew the fleet [Pourmahabadian and Mansouri, 2006]. Dust is an exception among these parameters, because the dust originates from the Iraqi deserts and covers west (Kermanshah province) and south of the country for months. One of the most important issues regarding the dust is that the government of Iran cannot restrict the arrival of it to Iran. When dust arrives to Kermanshah, It is not possible to see anything for a distance of over 100 meters, showing the problem is not easy to remedy.

Temperature can be used as a surrogate for the meteorological factors influencing surface ozone formation [Ryan *et al.*, 1998, Camalier *et al*., 2007]. Temperature has been rising, on average, in the world. Surface ozone is expected to rise, all else being equal, with an increase in temperature [EPA. 2006]. The results showed that between the level of ozone and temperature there is a positive relationship (Fig 1 and 2). The findings of Jacob et al, [Jacob *et al.,* 1993] showed the same result that is; there is strong correlation between temperature with high-O_3 events. Also, the ozone temperature relationship has been investigated in the past [Sillman and Samson, (1995), Sillman, 1999]. This correlation largely reflects three key processes: ventilation of surface air, with higher temperatures associated with stagnant air [Jacob *et al.,* 1993]; local O_3 production chemistry, in particular the thermal dependence of PAN de-composition [Sillman and Samson, 1995]; temperature-sensitive biogenic emissions, most notably isoprene [Guenther *et al*., 2006]. Increases in other emissions such as wildfires and air-conditioning use in response to higher temperatures may further amplify the O_3 response.

The correlation coefficients of air quality parameters are shown in Table 2. There were significantly negative correlation between O_3 concentrations and the nitric oxide concentrations ($P < 0.05$ in 2008 and 2009), and, between O_3 concentrations and CO concentration ($P < 0.01$ in 2008 and $P < 0.001$ in 2009), while there was a significantly positive correlation between O_3 concentrations and dust ($P < 0.05$ in 2008 and $P < 0.01$ in 2009). There was a positive correlation between NOx and CO ($P < 0.001$ in 2008 and $P < 0.01$ in 2009) and a negative correlation between NOx and dust ($P < 0.001$ in 2008 and 2009). Also, there was a negative correlation between dust and CO ($P < 0.01$ in 2008 and $P < 0.001$ in 2009). In other hand, there were no significantly correlations between SO_2 with other air pollutants (O_3, CO, NOx and dust). The lack of correlation between SO_2 and other variables, which are possibly, influenced more by buses than by cars [Wheeler *et al*., 2008], suggests that there is a significant contribution from diesel.

The air quality monitoring data collected in city centre of Kermanshah showed seasonal variations for ozone (O_3), nitrogen oxides (NO_x), sulphur dioxide (SO_2), carbon monoxide (CO) and dust concentrations (Table 3). There were significant differences in the concentrations of air pollution parameters at different season (spring, summer, autumn and winter). The statistical analysis indicated that there were significant differences in the O_3, NO_x and dust concentrations between winter and spring, between winter and summer, and, between summer and autumn. There was significant difference in the CO concentration between winter and summer, and, between summer and autumn. Also, there was significant difference in the SO_2 concentration between winter and summer, between spring and summer, and, between spring and autumn.

CONCLUSION

At the end the study of the results showed that NOx, SO_2, CO and dust parameters except O_3 increased in 2009 than 2008. Between the level ozone and temperature there was a positive relationship as well. The air quality monitoring data collected in city center of Kermanshah showed seasonal variations for ozone (O_3), nitrogen oxides (NOx), sulphur dioxide (SO_2), carbon monoxide (CO) and dust concentrations.

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REFERENCES

Allen RW, Davies H, Cohen MA, Mallach G, Kaufman JD, Adar SD. (2009). The spatial relationship between traffic-generated air pollution and noise in 2 US cities. Environ. Res., 109: 334–342.

Agrawal M, Singh B, Rajput M, Marshall F, Bell JNB. (2003). Effect of air pollution on peri-urban agriculture: a case study. Environ. Pollut., 126: 323–329.

Ashmore MR, Dimitroulopoulou C. (2009). Personal exposure of children to air pollution. Atmos. Environ., 43: 128–141.

Atash F. (2007). The deterioration of urban environments in developing countries: Mitigating the air pollution crisis in Tehran, Iran. Cities., 24: 399–409.

Cairncross EK, John J, Zunckel M. (2007). A novel air pollution index based on the relative risk of daily mortality associated with short-term exposure to common air pollutants. Atmos. Environ., 41: 8442–8454.

Camalier L, Cox W, Dolwick P. (2007). The effects of meteorology on ozone in urban areas and their use in assessing ozone trends. Atmos. Environ., 41: 7127-7137.

EPA. (2006). Air Quality Criteria for Ozone and Related Photochemical Oxidants. EPA/600/R-07/145A.

Guenther A, Karl T, Harley P, Wiedinmyer C, Palmer PI, Geron C. (2006). Estimates of global terrestrial isoprene emissions using MEGAN. Atmos. Chem. Phys., 6: 3181-3210.

Harrabi I, Rondeau V, Dartigues JF, Tessier JF, Filleul L. (2006). Effects of particulate air pollution on systolic blood pressure: A population-based approach. Environ. Res., 101: 89–93.

Hoek G, Beelen R, Hoogh K, Vienneau D, Gulliver J, Fischer P. Briggs D. (2008). A review of land-use regression models to assess spatial variation of outdoor air pollution. Atmos. Environ., 42: 7561–7578.

Jacob DJ, Logan JA, GardnerGM, et al. (1993). Factors regulating ozone over the the United States and its export to the global atmosphere. J. Geophysic. Res., 98: 817-14-826.

Jalaludin BB, O'Toole BI, Leeder SR. (2004). Acute effects of urban ambient air pollution on respiratory symptoms, asthma medication use, and doctor visits for asthma in a cohort of Australian children. Environ. Res., 95: 32–44.

Pourmahabadian M, Mansouri N. (2006). Carbon monoxide monitoring at stationary and mobile stations. J. Appl. Sci., 6: 1384-1388.

Ryan WF, Doddridge BG, Dickerson RR, Morales RM, Hallock KM, Roberts PT, Blumenthal DL, Anderson JA, Civerolo KL. (1998). Pollutant transport during a regional O_3 episode in the mid-Atlantic states. J. Air. Wast. Manag. Assoc., 48: 786-797.

Scoggins A, Kjellstrom T, Fisher G, Connor J. Gimson N. (2004). Spatial analysis of annual air pollution exposure and mortality. Sci. Total. Environ., 321: 71–85.

Sillman S. (1999). The relation between ozone, NOx and hydrocarbons polluted rural environments. Atmos. Environ., 33: 1821-1845.

Sillman S. SamsonFJ. (1995). Impact of Temperature on Oxidant Photochemistry in Urban, Polluted Rural and Remote Environments. J. Geophysic. Res., 100: 11497-11508.

Singha A, Agrawalb SB, Rathore D. (2005). Amelioration of Indian urban air pollution phytotoxicity in Beta vulgaris L. by modifying NPK nutrients. Environ. Pollut., 134: 385–395.

Škarek M, Čupr P, Bartoš T, Kohoutek J, Klánová J. Holoubek I. (2007). A combined approach to the evaluation of organic air pollution - A case study of urban air in Sarajevo and Tuzla (Bosnia and Herzegovina). Sci. Total. Environ., 384: 182–193.

Taseiko OV, Mikhailuta SV, Pitt A, Lezhenin AA, Zakharov YV. (2009). Air pollution dispersion within urban street canyons. Atmos. Environ., 43: 245–252.

Wheeler AJ, Smith-Doiron M, Xu X, Gilbert NL, Brook JR. (2008). Intra-urban variability of air pollution in Windsor, Ontario- Measurement and modeling for human exposure assessment. Environ. Res., 106: 7–16.

Wilson AM, Salloway JC, Wake CP, Kelly T. (2004). Air pollution and the demand for hospital services: a review. Environ. Inter., 30: 1109–1118.

Yang CY, Chang CC, Chuang HY, Tsai SS, Wu TN, Ho CK. (2004). Relationship between air pollution and daily mortality in a subtropical city: Taipei, Taiwan. Environ. Inter., 30: 519– 523.

Zhang M, Song Y, Cai X. (2007). A health-based assessment of particulate air pollution in urban areas of Beijing in 2000–2004. Sci. Total. Environ. 376: 100–108.

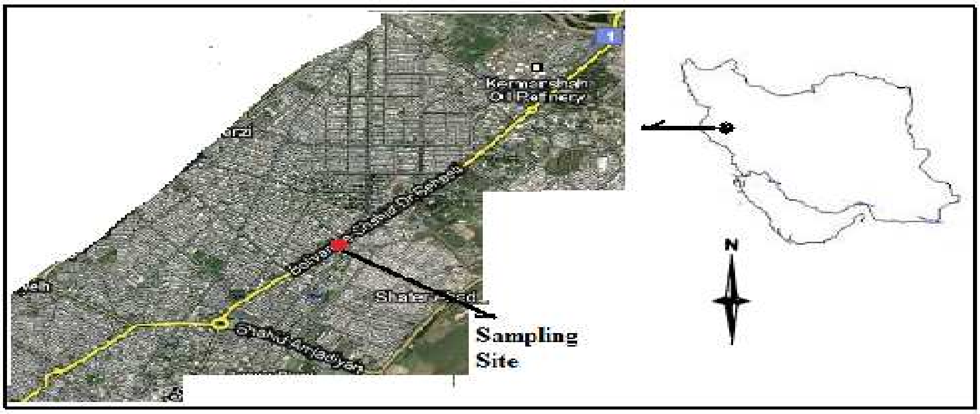

Fig. 1 – Location of monitoring site for O_3, NOx, SO_2, CO and dust

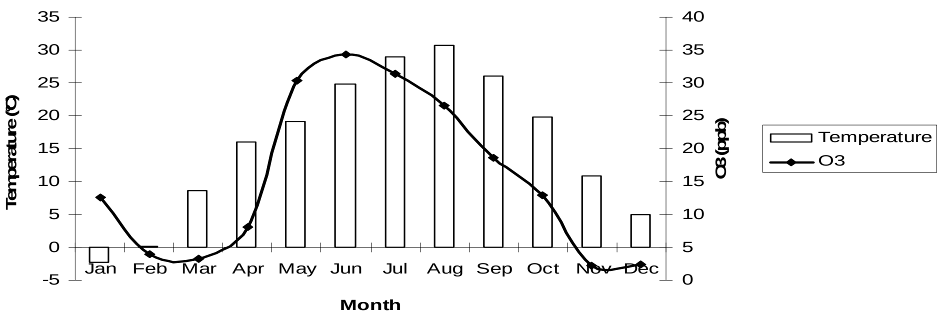

Fig. 1- Relationship between Temperature with Ozone levels in 2008

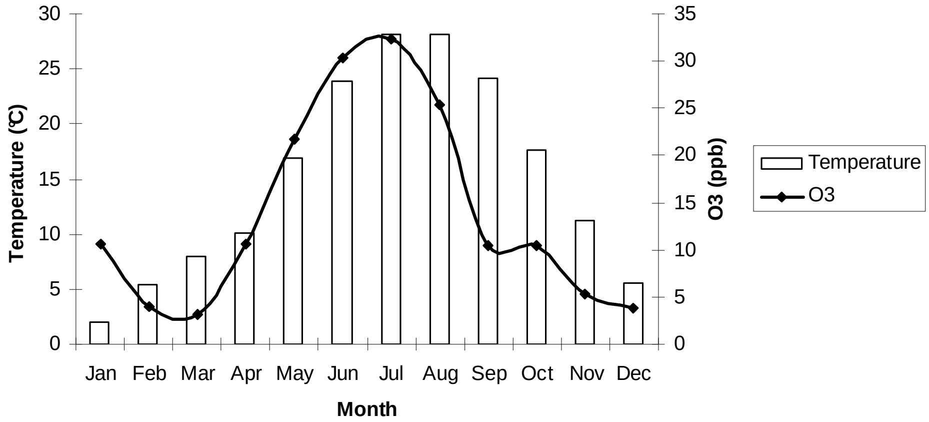

Fig. 2- Relationship between Temperature with Ozone levels in 2009

Table 1- Mean pollutant concentrations during different seasons at different sites in Kermanshah city

		2008					2009				
	Month	O_3 ppb	NOx ppb	Dust μg/m^3	SO_2 ppb	CO ppm	O_3 ppb	NOx ppb	Dust μg/m^3	SO_2 ppb	CO ppm
Winter	Jan	12.6	84.4	74.7	20.1	2.7	10.6	79.0	68.4	20.6	3.2
	Feb	3.9	41.0	142.3	23.4	2.1	5.3	39.4	125.7	25.4	3.4
	Mar	3.2	30.0	185.3	24.1	2.0	7.0	33.9	190.4	23.1	2.3
Spring	Apr	8.1	27.9	228.8	24.5	2.0	10.6	30.5	217.4	24.7	2.7
	May	30.3	20.3	214.7	19.5	1.3	21.8	24.7	195.9	20.4	2.0
	Jun	34.3	17.8	236.2	21.1	1.2	30.4	19.5	243.2	19.5	1.2
Summer	Jul	31.3	20.6	191.5	25.2	1.5	32.4	20.0	257.3	26.5	1.1
	Aug	26.6	22.3	176.4	27.8	1.7	25.4	21.8	210.9	28.8	1.8
	Sep	18.7	21.6	217.9	25.6	1.4	10.5	24.8	237.5	30.7	1.6
Autumn	Oct	13.0	32.1	122	28.1	2.1	10.5	30.5	135.6	25.3	2.2
	Nov	2.3	39.9	76.5	24.5	2.6	5.3	40.6	95.4	26.3	3.1
	Dec	2.5	57.7	68.6	22.7	2.3	3.8	55.4	71.2	24.7	2.8
Overall mean (±SD)		15.6 (12.2)	34.6 (19.4)	161.2 (62.6)	23.9 (2.7)	1.9 (0.5)	14.5 (10.2)	35.0 (17.3)	171.7 (67.4)	24.7 (3.4)	2.3 (0.8)

Table 2- Pearson's correlation coefficients of monthly air pollution data during 2008-2009 at station in Kermanshah

	O_3	NOx	SO_2	CO	Dust
2008					
O_3	1				
NOx	-0.55*	1			
SO_2	-0.12	-0.36	1		
Co	-0.82***	0.82***	-0.1	1	
Dust	0.61*	-0.81***	0.15	-0.79**	1
2009					
O_3	1				
NOx	-0.58*	1			
SO_2	-0.15	-0.29	1		
CO	-0.79**	0.75**	0.10	1	
Dust	0.71**	-0.86***	0.18	-0.86***	1

Degree of significance (*p < 0.05, **p < 0.01, ***p < 0.001)

Table 3- The analysis of variance (ANOVA) of the data at different seasons

Parameter	*F*	p
O_3	10.3	p<0.001
NOx	6.5	p<0.01
SO_2	10	p<0.001
Co	7.2	p<0.01
Dust	20.5	p<0.001

p significance level

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